

RAINFALL IN THE SUHARD MOUNTAINS FROM BUCOVINA

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Received 9 December 2011, accepted 5 February 2012

Abstract: *In the study of the rainfall from Suhard Mountain, we used data from meteorological stations and rainfall stations situated in the immediate vicinity, which ensured a relatively satisfactory interpretation of this parameter.*

The altitude difference registered in Suhard, 1262 m (between the 670m, at the confluence of Maria River with Someșul Mare and 1932 m of Omu Peak), generates a remarkable spatial variation of rainfall. As a true reflection of the local geographical conditions, the rainfall quantities graphs don't describe anymore a proportional linear increase with the altitude, but mildly resembling a parable. The type of precipitations which characterizes especially the cold season increases in days proportionally with the altitude. The consequence, besides a large amount of solid water, is also noticeable in the termic regime.

Keywords: *rainfall, variation, climatic hazards, humidity excess, rainfall, deviation, frequency.*

1. Introduction

Suhard's role of climatic barrier complicates rainfall regime and distribution [1].

The orientation of the main peak, almost perpendicular to the direction of movement of air masses, the increase in altitude in North-West determines the reactivation of cloud systems and larger quantities of rainfall in this direction, which is totally opposite of Bistrița's lane, situated in the "underwind" area, or Dornelor's depression, where the phenomenon of foehn takes place, which destroys the descending cloud systems from the Eastern peaks of Bârgău's Mountain [2].

A study on rainfall differences from between the Eastern and Western parts of Eastern Carpathians, realized by N. Barbu

and M. Apăvăloaiei (1975), highlights the part of orographic obstacle played by this Carpathian branch, in the Western region of it being recorded larger quantities, with a difference of 200-300 mm from the Eastern part.

2. Materials and methods

Because the weather and rainfall stations are missing from the inside of the mountainous area we study, monthly and daily data about rainfall from the higher or lower areas around this one were used [3]. Based on the use of GIS and the corrections to real data recorded around Suhard Mountain, annual and semiannual maps were developed, De Martonne dryness index and mountains exhibition maps, both with important roles in the local differentiations of rainfall [4].

3. Results and Discussion

The reality on the field is proved by data registered in the neighboring rainfall and weather stations: Ciocănești, (840 m) with 606.3 mm, Poiana Stampei (915 m) with 651 mm, Vatra Dornei (800 m) with 657 mm, Cîrlibaba (930 m) with 699 mm, Iezer (1735 m) with 1247 mm, Rarău (1632m) with 907 mm. We mention that we didn't take into account the data from Reșița weather station (2020 m) which, given the location and relatively short string of observations, registers only an annual average rainfall quantity of 524.6 mm (1991-2009) [7].

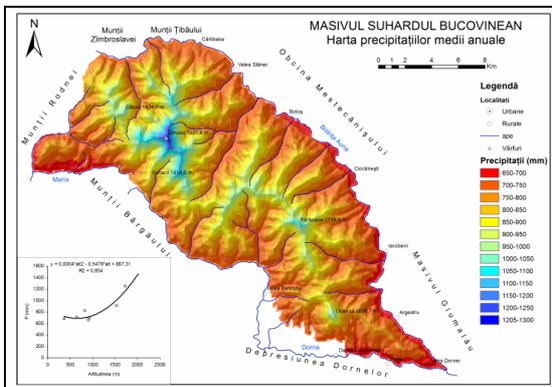


Figure 1. Map of annual average rainfall of Suhard Mountain from Bucovina

Average annual rainfall amounts from areas in close proximity are located between 651 mm in Poiana Stampei and 1267 mm in Iezer [5]. The inferior limit of the mountain, at contact with the depression, registers a smaller quantity than areas from lower altitudes, but positioned in the West, as a proof being the 650 mm from Poiana Stampei in comparison with the 684 mm from Bistrița's station. Nevertheless, the 700 mm value can be found in almost the entire area of Suhard Mountain (figure 1). In altitude, the increase is slower until 1600 m, where values can reach up to 1000 mm or even more above this height. An increase of values in North-West is added up, reaching 1250-1300 mm in Omu Peak

[6]. Even though some sources present higher values, with approximately 100 mm (RPR Monography, 1960), the situation can be explained by the fact that the analysis involves another interval of time, possibly more humid.

It is highlighted the patchy nature of rainfall, with quite large variations from year to year. For example, in Iezer, they were from 951 mm, which is 75% from the annual average, and 1935 mm, 152% from annual average.

The semiannually situation indicates that in the entire area, 60% of the total quantities of rainfall take place in the warm semester (between April and September). For lower areas, we can notice higher weights to 70%, with a slight decrease towards South-North. In altitude, the degree of continental is perfectly illustrated: at Iezer just 60% (weight approaching the one of Bistrița), while in Rarău the weight of 72% exceeds even the one of Vatra Dornei, 70%.

In the cold semester, the average quantities vary from 197mm in Vatra Dornei, to 497 mm in Iezer (table1, fig. 2). Compared to the annual situation, the graph of rainfall distribution, in the cold semester, according to the altitude, describes a more pronounced parabola, showing the important part of local conditions in registering rainfall quantities. The entire area we study is delimited by the values of 200-250 mm, and at higher altitudes, of 1600 m, the increases are more noticeable, from 400 mm to over 600 mm.

The continental degree was analyzed according to the Martonne dryness index (table 1 fig 31), which expresses the deficit/excess of humidity, calculated by the formula $Ia = P / (T + 10)$ (P is the average annual rainfall, T is the average annual temperature) and whose higher values emphasizes an humidity excess. For the studied area it is obvious the growth tendency with the altitude of the Martonne index.

The annual average quantities increase with the altitude, being at minimum in winter and maximum during summer. This way, from 24 mm in Poiana Stampei, in February and 67mm at Iezer in January, in June it can be reached 104 mm in Poiana Stampei and 160 mm in Iezer. Analyzing the variation of annual average quantities of rainfall, it is noticeable the maximum from June, no matter the altitude, and the minimum from January-February.

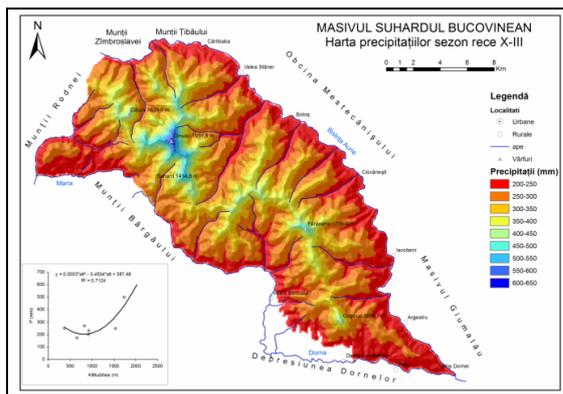
Quantitatively speaking, the increase is constant starting with winter months (with small differences among them and among stations) and continues until the beginning of summer. We can talk about the summer maximum (June-July), noticeable at all stations disregarding the altitude.

At the end of summer, the quantities constantly decrease until the winter interval. Besides the increase in quantities according to the altitude, the major difference between station at higher altitude and the lower ones consists in more constant values, proportionally with the altitude.

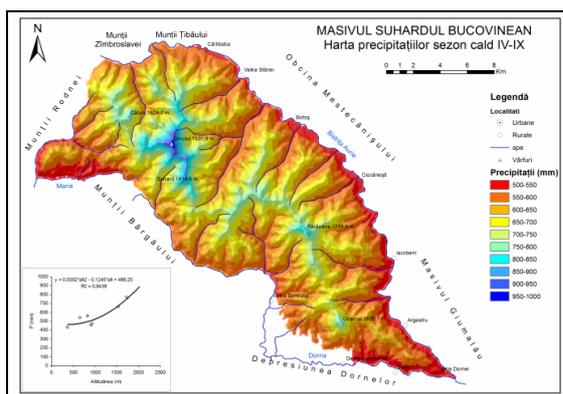
So, at Iezer, besides the winter minimum, the rest of the months register more than 800mm and monthly average of over 100mm 6 months a year. In Rarău, station located with only 200 m lower, but towards East, the quantities not only represent 70% from those in Iezer but are there less than 50 mm and average values over 100 mm appear only in 4 months. (table 2, figure 4).

At lower stations, the values are of 70mm, at Poiana Stampei half of the year has a minimum of 50mm and the maximum is of over 100mm.

24 hours maximum quantities are related to the continental influence and local particularities of cloud-burst rainfall and were registered valleys and depressions. Here are a series of values representing national records (table 3). It's the case of the 280.4 mm registered in Cîrlibaba, on July, 16 1938, and reported in the newsletter edited by INMH, the fourth most large in the country, the third of the month of June and second in the mountain area.



a



b

Figure 2. The half-year repartition of average rainfall (cold season-a, warm season-b)

Table 1. Annual average sums of rainfall, cold semester (Sr), warm semester (Sc) and De Martonne index

| Station | An | Sr | Sc | de Martonne |
|----------------|------|-----|-----|-------------|
| Bistrița | 684 | 251 | 433 | 37.17391 |
| Campulung | 709 | 172 | 537 | 42.71084 |
| Vatra Dornei | 657 | 197 | 460 | 54.76821 |
| Poiana Stampei | 651 | 198 | 453 | 45.13889 |
| Rarău | 907 | 247 | 660 | 73.14516 |
| Iezer | 1267 | 497 | 769 | 109.386 |

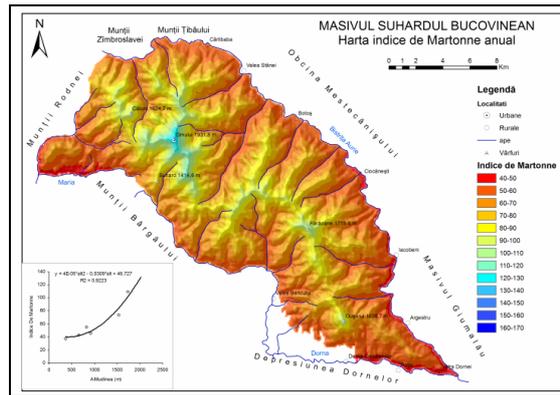


Figure 3. The distribution of De Martonne index of aridity

Table 2
Monthly average quantities of rainfall, registered at the weather stations around Suhard

| Stația | Alt.(m) | I | F | M | A | M | I | I | A | S | O | N | D | interval |
|----------------|---------|----|----|----|-----|-----|-----|-----|-----|-----|----|----|----|-----------|
| Bistrița | 365 | 42 | 33 | 33 | 57 | 75 | 93 | 78 | 68 | 52 | 46 | 46 | 52 | 1950-2000 |
| Vatra Dornei | 825 | 27 | 28 | 34 | 48 | 86 | 99 | 95 | 82 | 50 | 46 | 35 | 28 | 1988-1995 |
| Poiana Stampei | 915 | 29 | 24 | 30 | 50 | 78 | 104 | 98 | 72 | 51 | 41 | 35 | 38 | 1970-2009 |
| Cîrlibaba | 960 | 32 | 24 | 42 | 63 | 97 | 93 | 87 | 75 | 55 | 52 | 40 | 40 | 1969-1998 |
| Rarău | 1536 | 39 | 39 | 47 | 76 | 122 | 144 | 138 | 110 | 71 | 46 | 38 | 40 | 1961-2000 |
| Iezer | 1735 | 67 | 69 | 81 | 101 | 127 | 160 | 155 | 127 | 101 | 99 | 96 | 85 | 1958-2006 |

Recorded values appear in a series of works on the surrounding landscape units, which we haven't found published in professional newsletters. This way, in Vatra Dornei, on the 5th of September 1912, the quantity of 260 mm was recorded, considered to be the largest quantity produced in other period than summer, at country level. There are also values from the rainfall station of Gura Țibăului, 140,6 mm at July, 18 1951 and Iacobeni, 63,1 mm, on June, 14 1949.

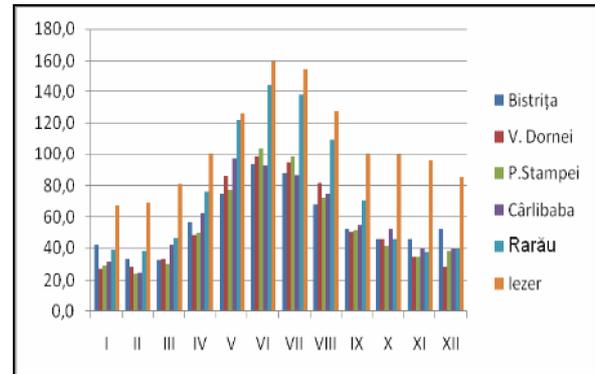


Figure 4 Monthly average rainfall

Table 3.
Monthly maximum rainfall registered in 24 hours, absolute maximum and the date of occurrence

| Station | I | F | M | A | M | I | I | A | S | O | N | D | Max. | Data |
|----------------|------|------|------|------|------|--------------|-------------|------|------|------|------|------|-------|------------|
| Poiana Stampei | 23.4 | 19.6 | 26.3 | 23.5 | 59.4 | 48.8 | 68.1 | 44.6 | 43.0 | 37.1 | 32.3 | 25.6 | 68.1 | 9.07.1999 |
| Iezerul Rodnei | 34.4 | 37.1 | 38.4 | 45.3 | 66.1 | 61.0 | 80.8 | 60.5 | 62.1 | 70.6 | 50.5 | 48.1 | 80.8 | 29.07.1966 |
| Vatra Dornei | 20.0 | 27.9 | 23.2 | 44.5 | 62.1 | 51.0 | 65.2 | 49.7 | 26.0 | 34.2 | 34.3 | 19.2 | 65.2 | 5.09.1912 |
| Ciocănești | 19.0 | 24.7 | 17.8 | 20.2 | 42.7 | 37.8 | 54.5 | 35.8 | 43.5 | 24.0 | 23.2 | 24.0 | 54.5 | 22.07.1974 |
| Cîrlibaba | 20.0 | 20.1 | 21.5 | 32.5 | 50.0 | 280.0 | 36.6 | 70.0 | 61.5 | 28.2 | 29.0 | 31.7 | 280.0 | 16.06.1938 |
| Rarău | 30.9 | 34.9 | 33.4 | 88.7 | 56.0 | 110.6 | 91.0 | 71.5 | 60.2 | 38.5 | 27.6 | 29.7 | 110.6 | 29.06.1978 |

The average of the days with rainfall quantities 0,1 were analyzed based on the data from Poiana Stampei and Iezer stations, which are considered

representative for the high area of Suhard Mountain (table 4).

For the number of days with rainfall bigger or equal with 0,1 mm, we

can observe the increase in it according to the altitude, from 160 days at the boundary with depression, which is over 40% of the year) to 194 days at 1700m, representing more than half a year. Therefore, it is an increase with approximately 10% at a difference of 800 m in altitude, which leads us to the conclusion that at the Omu Peak, the number of rainfall days doesn't exceed with much the value of 200.

Liquid rainfall, speaking in number of days, predominates in Poiana Stampei between April and October and in Iezer between May and October. Rain represents the most important type of liquid rainfall, which can appear in each month of the year, in the entire mountainous area (table 5, fig. 5).

Table 4.
Number of days with rainfall bigger or equal with 0,1mm

| Station | I | F | M | A | M | J | J | A | S | O | N | D | Total |
|----------------|------|------|------|------|------|------|------|------|------|------|------|------|-------|
| Poiana Stampei | 12.5 | 11.6 | 12.2 | 14.0 | 16.0 | 17.5 | 16.1 | 13.3 | 11.1 | 9.6 | 12.0 | 14.2 | 160.1 |
| Iezer | 15.9 | 16.0 | 17.7 | 17.9 | 18.4 | 18.8 | 17.8 | 14.2 | 13.1 | 12.3 | 15.4 | 17.0 | 194.5 |

Table 5.
Number of days with liquid and solid rainfall

| Station | liquid | I | F | M | A | M | J | J | A | S | O | N | D | Total |
|----------------|--------|------|------|------|------|------|------|------|------|------|-----|------|------|-------|
| Poiana Stampei | | 2.4 | 2.5 | 5.6 | 11.2 | 15.7 | 16.6 | 15.8 | 12.7 | 10.6 | 8.8 | 6.5 | 4.1 | 112.5 |
| Iezer | | 0.3 | 0.8 | 1.7 | 6.2 | 14.6 | 17.7 | 17.9 | 13.6 | 11.6 | 8.7 | 4.6 | 1.9 | 97.1 |
| | solid | | | | | | | | | | | | | |
| Poiana Stampei | | 11.7 | 10.5 | 9.5 | 5.6 | 0.6 | 0.0 | 0.0 | 0.0 | 0.2 | 2.3 | 7.5 | 12.1 | 60.0 |
| Iezer | | 15.6 | 15.0 | 16.3 | 15.7 | 6.0 | 3.5 | 2.3 | 1.5 | 5.2 | 7.2 | 12.4 | 16.1 | 110.6 |

The number of days with solid rainfall at the contact with the depression reaches the maximum in December, while in altitude happen between March and April (figure 5).

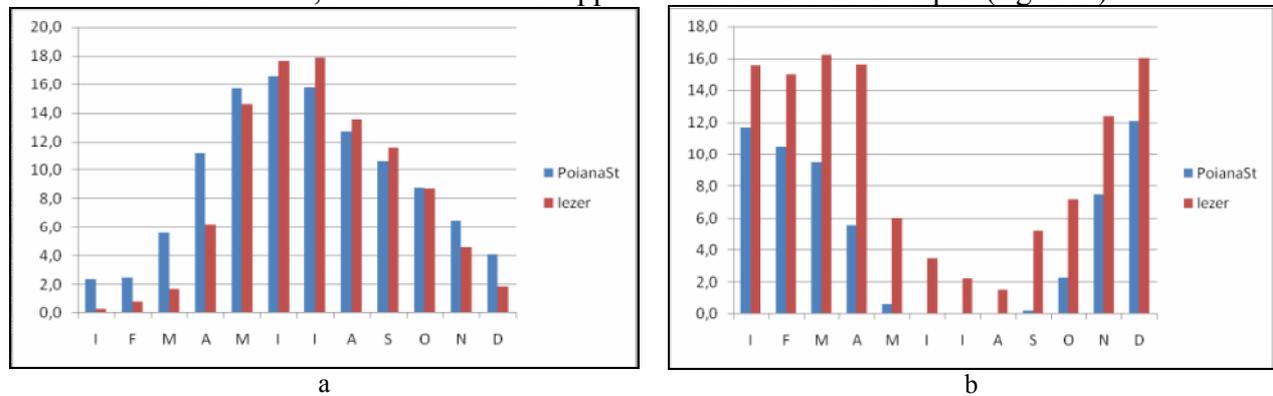


Figure 5. Number of days with liquid (a) and solid (b) rainfall

Number of days with snow

The type of precipitations which characterizes especially the cold season increases in days proportionally with the altitude. The consequence, besides a large amount of solid water, is also noticeable in the termic regime. From analyzing the

data, for the Suhard Mountain, a weight of this phenomenon is found between 33% from marginal areas and 45% at over 1700%. These values may be further discussed both because of the particular situations of the stations which recorded them and the field configuration (table 6, fig. 6).

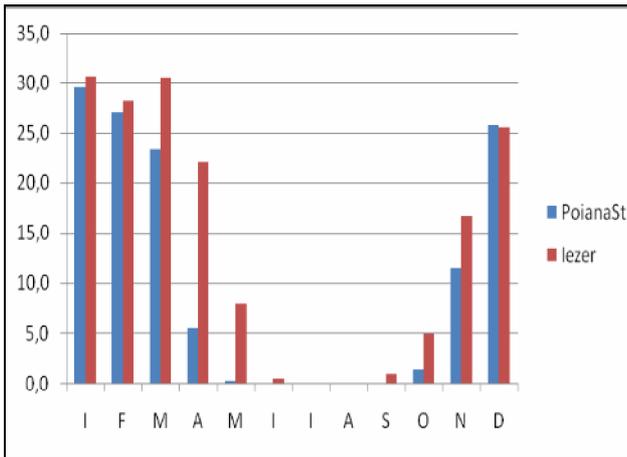


Figure 6. Number of days per month with layer of snow

Starting from the map of the mountains' orientation (figure 7), in our analysis, we can see that more than one third of the peaks in Suhard go towards North, North – East, North-West, which helps maintain the snow for a long period of time.

Adding also the vast surfaces of forests, we can infer that the data from Iezer are valid for a much larger area than the altitude level they are registered at.

From our observations, yearly speaking, on the North-Eastern peak of Omu, the layer of snow exists even after the 15 of June and under Oușoru Peak it can maintain itself until the beginning of the same month.

Table 6. Number of days with layer of snow

| Station | I | F | M | A | M | I | I | A | S | O | N | D | Total |
|----------------|------|------|------|------|-----|-----|-----|-----|-----|-----|------|------|-------|
| Poiana Stampei | 29.6 | 27.1 | 23.4 | 5.4 | 0.2 | - | - | - | - | 1.4 | 11.5 | 25.8 | 124.4 |
| Iezer | 30.7 | 28.2 | 30.6 | 22.1 | 8.0 | 0.6 | 0.1 | 0.1 | 1.0 | 5.0 | 16.8 | 25.6 | 167.2 |

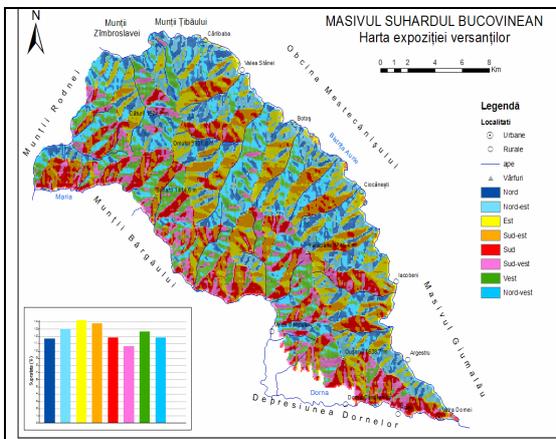


Figure 7. Exposure of peaks from Suhard Mountain

These are the areas where the shattered snow in quantities big enough to produce avalanches. Meanwhile, on the sunny peaks, there are chances for the snow to be missing even in the middle of winter, fact depicted by the intensity of GELIFRACTIE process.

Lower, at the forests level, the same orientation (South East, South and South West) determines shrinkage in the snowy interval of time during spring, but also a possible later installation of snow.

4. Conclusions

In the area of the Suhard's Mountain from Bucovina, the quantities of annual, semiannual, monthly and daily rainfall have a great variability, both in space and time. Thus, annual average sums are between 700 mm at lower altitudes and over 1250 mm around Omu Peak (1932 m). Variation of precipitations is between 0mm, in clear, without rainfall days and 280 mm, the maximum quantity registered in Cîrlibaba, on June, 16 1938.

Most of the rainfall occurs in the warm semester, approximately 60%, when the maximum number of liquid rainfall days is also registered. The maximum number of days with solid rainfall occurs in the cold season.

5. References

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